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A long-term transformation of sequestrated CO_2 by deep microbial biocenosis?

N. Hoth (1), S. Ehinger (2), T. Muschalle (1), J. Seifert (2), C. Freese (1) & M. Schlömann (2)

(1) Dept. of Drilling Engineering and Fluid Mining , TU Bergakademie Freiberg, Germany, (2) Chair of Environmental Microbiology, TU Bergakademie Freiberg, Germany (Nils.Hoth@tbt.tu-freiberg.de / Fax: 0049/(0)3731/392502 / Phone: 0049/(0)3731/393213)

The idea of CO_2 sequestration to reduce the anthropogenic contribution to the atmospheric CO_2 concentration, has gained practical importance. The different sequestration concepts have primarily a hydrodynamic–geochemical point of view. In contrast our "RECOBIO" project, as part of the BMBF-GEOTECHNOLOGIEN program, studies the, until now, minor investigated question of the biogeochemical impact of sequestrated CO_2 to the relevant deep geological formations. The importance of the deep microbial biocenosis and therefore of autotrophic metabolism has been shown in the last decade. In reduced deep environments sequestrated CO_2 may serve as electron acceptor and carbon source of microbial pathways. The main question is the biogeochemical long-term transformation. Therefore the focus of this project is on methane formation, autotrophic sulfate reduction as well as microbial impact on the formation of carbonate phases. Methane formation represents a long-term transformation to an energy source, while autotrophic sulfate reduction is coupled to the problem of acid gas generation. The formation of carbonate phases can result in an important increase of the sequestration capacity. The overall objective of the project can be summarized in three main topics:

a) Evidence of the relevant microorganisms at the two chosen sites (oil and gas field) within the North German Basin

b) Investigation of the existing electron donators and their CO_2 induced supply

c) Autoclave experiments on the biogeochemical transformation with original formation waters (autochthonic microorganisms) and minerals/ rock materials.

This work presents the first main results to topics a) and c).

The characterization of the microbial communities by molecular techniques gave an essential insight to the biocenosis of the selected sites. The archaeal communities are dominated by methanogens. Autotrophic methane forming (reduction of CO_2) species and species with heterotrophic metabolisms are shown analyzing the clone library. The detailed phylogenetic analysis of the bacteria points to the presence of halo- and thermophilic species. Sulfate reduction, fermentation and methanogenesis are stated as the main metabolic activities at the site, which can be well linked to the properties of the formation waters.

Within the autoclave experiments the generation of H_2 on iron minerals was shown. Autochthonous microorganisms from the produced formation waters of the gas field metabolize this H_2 together with CO_2. Sulfate reduction is the main process, which is caused by high sulfate concentrations of the formation waters. After depletion of sulfate methane formation can start. Generally the processes are linked to carbonate formation by the shift within the pH-values and the supply of cations.